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### **ADDENDUM TO “BENDING THE MEDICARE COST CURVE IN 12 MONTHS OR LESS”: AHS ANALYSIS FOR SAMPLE OF PURE NORTH SENIORS (55-PLUS)**

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As part of our analysis in the paper published in January 2015, “Bending the Medicare Cost Curve in 12 Months or Less: How Preventative Health Care Can Yield Significant Near-Term Savings for Acute Care in Alberta,”<sup>1</sup> we had carried out analyses of sub-groups of interest, such as workers at Canadian Natural Resources Ltd. (CNRL) and seniors (participants aged 55-plus) that, for reasons of length, we did not include in the published paper. The details for the data, the models estimated, the statistics calculated and the sample inclusion and exclusion restrictions are described in the full paper that was peer reviewed.

This addendum discusses the results of the analysis of the sample of seniors (participants aged 55 and up at the time of joining Pure North, n=5,516, made up of 2,758 Pure North participants and 2,758 age- and sex-matched controls). The models estimated are described on pages 9 and 10 of the published paper. Persisting participants are Pure North joiners who have a 25OHD (vitamin D blood serum) measure at the time of joining and one year later. We interpret participants with two 25OHD one year apart as persisting in the Pure North program but we do not infer the degree of adherence to the program.

The In-Clinic Seniors Program (ICP) sub-sample of Pure North senior participants had over 90 per cent persistence in the program for at least one year. For this sub-sample, relative to the frequency of hospital and emergency department visits of the ICP seniors program participants and matched controls in the year prior to joining the program, the program reduces hospital visits for seniors in the program by 22 per cent, emergency department visits by 34 per cent and avoids 22 per cent of annual health-care costs. For the 68 per cent of the full sample of Pure North participants aged 55 and over who we can confirm persisted in the program for at least one year, relative to the frequency of hospital and emergency department visits of the program participants and matched controls in the year prior to joining the program, the program reduces hospital visits for seniors persisting in the program by 39 per cent and emergency department visits by 24 per cent. These reductions in health care system contacts result in public health-care expenditures avoided of 35 per cent per year. These magnitudes are comparable to what we calculated for the overall and Vital 2.2 samples in the full 2015 report.

<sup>1</sup> Daniel J. Dutton et al., “Bending the Medicare Cost Curve in 12 Months or Less: How Preventative Health Care Can Yield Significant Near-Term Savings for Acute Care in Alberta,” University of Calgary School of Public Policy Research Paper 8, 2 (January 2015).

Not accounted for in those direct health-care costs avoided is the relief that preventative care can provide to the medical treatment system. Scaled to the population level, the reductions observed in the Pure North seniors sample would represent at least six per cent fewer visits to Alberta emergency departments per year and reduce the need for hospital beds by at least six per cent in the Alberta hospital system. In terms of freed-up hospital beds, this is equivalent to adding another Foothills Medical Centre to the Alberta health-care system.

## RESULTS FOR THE SENIORS SAMPLE:

Table 1 presents summary statistics for the seniors sample and the overall and Vital 2.2 samples, which were our focus in the published paper. The overall and Vital 2.2 samples are discussed in the 2015 published paper and include seniors in the samples. Looking at seniors (aged 55 and up at time of joining) as a distinct sample, the average age of joiners was 64, and 60 per cent of joiners were female. As expected, average use of hospitals (DAD) was higher for seniors than for the other samples, but average use of emergency departments was not clearly higher prior to joining. The seniors sample had a higher proportion of persisting Pure North participants than did the other samples.

**TABLE 1 MEAN VALUES OF DEMOGRAPHIC AND HEALTH-CARE UTILIZATION MEASURES FOR PROGRAM PARTICIPANTS AND MATCHED CONTROLS IN YEAR PRIOR TO JOINING PURE NORTH**

Summary statistics for sample, year prior to joining						
	Overall		Vital 2.2		Seniors (all)	
	Cases	Controls	Cases	Controls	Cases	Controls
Average age	51.44		53.57		64.39	
Proportion female	56.65%		60.09%		60.48%	
Proportion user (DAD)	6.24%	6.40%	6.80%	6.73%	7.18%	7.65%
Average use (DAD)	0.085	0.089	0.093	0.095	0.096	0.115
Average nights (DAD)	0.429	0.538	0.485	0.602	0.541	0.809
Proportion user (ED)	27.19%†	22.24%	27.47%†	23.08%	26%†	23.24%
Average use (ED)	0.586*	0.479	0.618*	0.499	0.527*	0.509
Proportion user (GP)	79.53%†	74.43%	-	-	-	-
Average use (GP)	3.91	3.88	-	-	-	-
Proportion of cases persisting (DAD & ED)	0.55		0.54		0.68	
Proportion of cases persisting (GP)	0.59		-		-	
N (DAD & ED)	5,689		4,277		2,758	
N (GP)	1,275					

\* indicates difference between cases and controls is statistically significant (Mann-Whitney U test,  $p < 0.05$ )

† indicates difference between cases and controls is statistically significant (Z test of proportions,  $p < 0.05$ )

As presented in the full 2015 published study, we estimate two types of models with a difference-in-differences approach. The first type is analogous to the intention-to-treat (ITT) analysis employed in studies with randomized treatment assignment in that we do not require individuals to adhere to the program to count as being “treated” -- we consider all participants as having access to the same treatment. This method has the advantage of providing estimates of effect mimicking real life circumstances when offering a voluntary intervention, that is, individuals will participate with varying levels of intensity. Statistically significant ITT estimates are strong evidence of a program’s effectiveness since they are still identified even if not all participants are adhering to the program. In contrast, statistically insignificant results are inconclusive evidence as to a program’s effectiveness in the sense

that it could be the case that the program is ineffective or that the program is effective for participants who adhere to it but the measured effect is diluted by the outcomes for non-adherents to the program.

The second type of model we estimate accounts for the fact that some individuals in the program may have stopped participating, or are not adhering to the program. Since the program is a voluntary program we can only observe contact with the Pure North program rather than conclusive evidence of adherence to the program. Thus, as discussed in the 2015 published paper we define persisting participants with respect to the most ubiquitous variable gathered by the program, blood serum 25OHD. All of the participants in our data set have a 25OHD measure at baseline. If a participant has a second measure of 25OHD 6 to 18 months after joining we define them as “persisting” in the program. If they do not have a second measure, then they are classified as non-persisting.

Table 2 presents the *intention to treat* (ITT) difference-in-differences estimates of the effect of the Pure North (PN) program on hospital and emergency department visits for program participants. These estimates show the changes in utilization over what was observed in the matched controls for all persons who joined the PN program. For example, a positive number indicates that the change for participants in the PN program was either a smaller increase than for the control sample, or a larger decrease than for the control sample. In either case, a positive ITT value shows the number of visits to hospital, emergency department or GP avoided per PN participant in the year after joining.

Table 2 shows that for the ITT models, seniors do not have a significant reduction in hospital, emergency department or GP use. This contrasts with the findings for the overall and Vital 2.2 samples, where PN participants have a statistically significant reduction in visits to hospital of around 0.022, around 20 per cent of the mean number of visits in the year prior to joining ( $p < 0.05$ ) in both samples. The seniors sample for GP visits is smaller than for the DAD and emergency department data sets due to the fewer fiscal years of GP data as discussed in the published paper.

**TABLE 2 ITT ESTIMATES OF MEAN REDUCTIONS IN HEALTH-CARE UTILIZATION OF PROGRAM PARTICIPANTS VERSUS THAT OF AGE- AND SEX-MATCHED CONTROLS**

Sample (n)	Hospital Visits	Nights in Hospital	ED visits	GP visits
Overall (11,466)	0.0216*	0.0276	0.0638	0.28
p-values	0.024	0.799	0.121	0.083
Seniors (5,516)	0.0112	-0.0214	0.0743	0.118
Vital 2.2 (8,554)	0.0234*	-0.0115	0.107*	-
p-values	0.043	0.931	0.004	

\* indicates the estimate is statistically significant ( $p < 0.05$ ).

In Table 3, where we consider participants as persisting for at least one year in the program (baseline 25OHD and 25OHD measure at one year), we see a larger reduction in hospital visits after joining for persisting participants than for participants as a whole in the ITT models. Now the reductions in hospital visits are 0.035, 0.042 and 0.037 respectively for the overall sample, Vital 2.2 and seniors samples, which constitute a roughly 40 per cent reduction in the mean number of hospital visits observed in the year prior to joining. There are significant reductions in emergency department visits for senior and Vital 2.2 participants, of 0.126 and 0.17 visits per year, which is a reduction of around 25 per cent of mean visits in the year prior to joining.

For non-persisting joiners in the overall sample and Vital 2.2, outcomes are statistically the same as what is observed for age- and sex-matched controls, suggesting that they were not adhering to the program. For non-persisting seniors, however, they have statistically insignificant increases in hospital visits, emergency department visits and GP visits over that observed for the age- and sex-matched controls in the year after joining.

**TABLE 3**

Difference-in-differences estimates for participants grouped by persisting status					
		Hospital Utilization		Emergency Department Visits	General Practitioner Visits
		Visits	Nights		
Overall	Persist	0.0348*	0.144	0.0835	0.21
	Non-Persist	0.00554	-0.115	0.0398	0.383
Seniors	Persist	0.0373*	0.262	0.126*	0.379
	Non-Persist	-0.0444	-0.625*	-0.0361	-0.261
Vital 2.2	Persist	0.0419*	0.143	0.171*	-
	Non-Persist	0.00198	-0.19	0.0331	-

\* indicates the estimate is statistically significant ( $p < 0.05$ )

To better understand why Pure North participants, and those who persist in particular, were not going to hospital as frequently as the age- and sex-matched controls, we looked at the ICD-10 codes for each hospital visit observed in the cases and controls in the year prior to joining PN and the year after joining PN. We report categories of diseases as denoted by ICD-10 codes that jointly cover the majority of reasons for going to the hospital disaggregated by category.

For the overall sample of participants, there were 109 fewer visits to hospital compared to what was seen in the sample of matched controls in the first year after joining the PN program. If we exclude visits to hospital due to pregnancy-related issues, then the difference is 69 hospital visits. For the Vital 2.2 cohort, compared to controls there were 92 fewer visits after joining (85 if pregnancy excluded), and there were 26 fewer visits for participating seniors. Participants who persisted in the program in all three samples (overall, seniors, and Vital 2.2) had absolute decreases in numbers of hospital visits, while those who did not persist experienced increases in visits comparable in magnitude to the controls after accounting for the smaller sub-sample size.

The ICD-10 categories showing the biggest differences between controls and cases (aside from pregnancy) were hospitalizations due to cancer, lung problems, and accidents. For seniors, those who persisted in the program at least one year had six fewer hospitalizations due to cancer while the controls and those who do not persist had 11 and eight more hospital visits for cancer respectively. Closer investigation of the “other” category of less frequently occurring ICD-10 categories revealed that there were a small number of seniors who did not persist that were receiving palliative care and accounting for a relatively large number of nights.<sup>2</sup> Fractures in the persisting participants are less frequent in the year after joining the Pure North program, especially to the legs, which could be due to fewer falls. Avoiding falls in the elderly population is important, as breaking a hip is a serious problem that can lead to pneumonia and other complications that result in high health-care resource use due to long recovery time. Pneumonia and chronic obstructive pulmonary disease (COPD) are controlled better in the cases (both non-persisters and persisters.) Arthritis and arthrosis are better controlled for both persisters and non-persisters, although the persisters entered the program in worse health than did the non-persisters.

The sample of seniors who do not persist is approximately one-half of the size of the sample that persist and one-third the size of controls. The proportion of the sample that does not persist with a complicated and serious diagnosis code, such as cancer, is higher for non-persisting participants than for persisting participants. The higher utilization of hospitals by seniors who do not persist compared to those who

<sup>2</sup> For these seniors who do not persist, the “Other” category contains the ICD-10 codes for rehabilitation after a surgery or disease (“convalescence”), codes for other medical care that could include procedures such as blood transfusions, and codes for miscellaneous treatment options with labels such as “other specified medical care.” Seniors are more likely to have longer or more complicated recovery or be put on palliative care than those in the Vital 2.2 cohort, so senior hospital time is more subject to volatility year over year.

persist and to controls is driven by intense use of hospital by those with serious diagnoses, which could preclude program participation.

To further investigate the impact of the Pure North program on hospital and emergency department use, we can distinguish between two categories of seniors in the Pure North program. In Calgary, participants aged 55 and over are enrolled in the In-Clinic Seniors Program (ICP). Over 80 per cent of the ICP participants in our sample joined the Pure North program between September 2012 and March 2013. The sample of non-ICP seniors, all other seniors in the data set, have joining dates and frequencies that are comparable to that of the overall sample.

Table 4 shows that a remarkable feature of the ICP seniors sample is the high proportion of participants persisting in the program for at least one year. Ninety-six per cent of the individuals in the ICP sample remain in the program for at least one full year, whereas only 42 per cent of non-ICP seniors persist at least one year. This tells us that the (statistically insignificant) increase in utilization for non-persisting seniors in Table 3 is arising from the non-ICP sample of seniors.

ICP seniors have a higher average age (66) than do non-ICP seniors (63) and a higher proportion of ICP seniors in our sample are female (65 versus 56 per cent non-ICP). They also appear to have better health than their age- and sex-matched controls, showing lower average visits to hospital and the emergency department in the year prior to joining the program. In contrast, the non-ICP seniors have higher average visits to hospital and the emergency department than does their control sample.

**TABLE 4 MEAN VALUES OF DEMOGRAPHIC AND HEALTH-CARE UTILIZATION MEASURES FOR PROGRAM PARTICIPANTS AND MATCHED CONTROLS IN YEAR PRIOR TO JOINING PURE NORTH**

	Seniors (all)		ICP		non-ICP	
	Cases	Controls	Cases	Controls	Cases	Controls
Average age	64.39		66.10		62.77	
Proportion female	60.48%		65.30%		55.92%	
Proportion user (DAD)	7.18%	7.65%	7.31%	8.88%	7.05%	6.49%
Average use (DAD)	0.096	0.115	0.090	0.139	0.102	0.092
Proportion user (ED)	26% <sup>†</sup>	23.24%	23.28%	23.96%	28.56% <sup>†</sup>	22.57%
Average use (ED)	0.527 <sup>*</sup>	0.509	0.408	0.534	0.64 <sup>*</sup>	0.486
Proportion user (GP)	-	-	-	-	-	-
Average use (GP)	-	-	-	-	-	-
Proportion of cases persisting (DAD & ED)	0.68		0.96		0.42	
Proportion of cases persisting (GP)	-		-		-	
N (DAD & ED)	2,758		1,340		1,418	

<sup>\*</sup> indicates difference between cases and controls is statistically significant (Mann-Whitney U test,  $p < 0.05$ )

<sup>†</sup> indicates difference between cases and controls is statistically significant (Z test of proportions,  $p < 0.05$ )

Table 5 presents the ITT difference-in-differences estimates for pre- and post-joining hospital and emergency department utilization for the full seniors sample excluding CNRL participants and the ICP and non-ICP seniors sub-samples. For the full seniors sample in Table 2, the ITT estimate for reduced hospital visits was insignificant and half the magnitude of the full Vital 2.2 (non-CNRL) sample aged 25 and over. The ICP seniors have an ITT estimate that is close to the significant Vital 2.2 estimate in Table 2 (0.0194 versus 0.0234) but the ICP estimate is statistically insignificant. This could be due to the lower power of the smaller size of the ICP senior sample. The ICP sample has statistically significantly lower use of the emergency department after joining Pure North and the change is larger than that for the full Vital 2.2 cohort in Table 2. For non-ICP seniors, the ITT estimate is close to zero and insignificant.

**TABLE 5 ITT ESTIMATES OF MEAN REDUCTIONS IN HEALTH-CARE UTILIZATION OF PROGRAM PARTICIPANTS VERSUS THAT OF AGE- AND SEX-MATCHED CONTROLS**

Sample (n)	Hospital Visits	Nights in Hospital	ED visits
ICP (2,680)	0.0194	0.1432	0.1381*
p-values	0.367	0.606	0.018
non-ICP (2,680)	0.0035	-0.177	0.0141
p-values	0.874	0.526	0.857
All seniors Non-CNRL	0.0169	-0.0428	0.0852
p-values	0.332	0.839	0.124

\* indicates the estimate is statistically significant ( $p < 0.05$ )

Table 6 presents the difference-in-differences estimates for hospital and emergency department utilization for the same seniors samples in Table 5, but accounting for whether participants persisted in the program at least one year. Not surprisingly, as few ICP seniors are non-persisting, the effect sizes for hospital and emergency department visits are not that different from those in Table 5. The estimates in Table 6 confirm that persisting participants in the non-ICP sample account for the results shown for the full seniors sample in Table 3.

**TABLE 6 ESTIMATES OF MEAN REDUCTIONS IN HEALTH-CARE UTILIZATION OF PERSISTING AND NON-PERSISTING PROGRAM PARTICIPANTS VERSUS THAT OF AGE- AND SEX-MATCHED CONTROLS**

		Hospital Utilization		ED
		Visits	Nights	
ICP	Persist	0.0187	0.1303	0.1426*
	Non-Persist	0.0363	0.4651	0.02520
non-ICP	Persist	0.0576*	0.5475*	0.0797
	Non-Persist	-0.035	-0.6932	-0.0327
All seniors non-CNRL	Persist	0.0505*	0.2977	0.1760*
	Non-Persist	-0.0589*	-0.8109*	-0.1197*

\* indicates estimate is statistically significant ( $p < 0.05$ )

To perform an evaluation of the economic significance of the impacts of the Pure North program on hospital and emergency department utilization, we use the ITT estimates for the ICP seniors sample. These estimates show the outcome of high levels of sustained participation in the program and we suspect that they are conservative estimates as they are generated from a relatively healthy sample of seniors with potentially less health-care use that can be prevented. The magnitudes of the reductions in health-care utilization for the non-ICP persisting sample support the interpretation that seniors in poorer health can generate larger reductions in hospital and emergency department use. While the ITT estimate for the reduction in hospital use for the ICP-seniors sample was not statistically significant, we choose to use it because it is close in magnitude to the statistically significant effect for the full Vital 2.2 sample in Table 2, which was the basis for our calculations in the 2015 published paper.

Relative to the frequency of hospital and emergency department visits of the ICP seniors program participants and matched controls in the year prior to joining the program, the program reduces hospital visits for seniors in the program by 22 per cent and emergency department visits by 34 per cent. As Table 7 shows, these reductions in contacts result in health-care costs avoided of 22 per cent per year.



**TABLE 7 BASELINE HEALTH-CARE UTILIZATION AND COST AND COSTS AVOIDED FOR ICP AND PERSISTING SENIOR PN PARTICIPANTS**

	Average visits per year	Average nights per visit	Cost per visit/night	Total Annual Expenditure	Costs Avoided ICP Seniors	Costs Avoided Persisting Seniors Full Sample
Hospital	0.096	10.6	\$1,414	\$1,439	\$290	\$559
ED	0.53		\$840	\$445	\$116	\$106
Total				\$1,884	\$407	\$665
Proportion of total cost					0.22	0.35

NOTES: The average visits per year and average nights per visit are for the full seniors sample participants in Table 1. See Dutton et al. (“Bending the Medicare”) for an explanation of the costs per visit/night. Persisting senior PN participant costs avoided are based on the differences-in-differences estimate reported in Table 3.

Table 7 presents the number of contacts per year for the full seniors sample. For the seniors control sample, each visit to hospital resulted in an average 10.6 nights per hospitalization. As discussed in the full 2015 report, for costs of utilization we use \$1,414 per night in hospital based on the billing rate for a night in hospital in Calgary, and \$840 per emergency department visit. Based on the mean frequencies of use in the year prior to joining the program, average expenditures on hospitalization and emergency department use for the public payer in Alberta would have been \$1,884 per senior participant. For the ICP seniors program participants, costs avoided are \$407, representing 22 per cent of health-care costs of hospital and emergency department use in the year prior to joining. Table 7 also shows that if the program effects for hospitalization and emergency department use are as large as those seen for persisting participants in the full seniors sample, then costs avoided are \$665 and 35 per cent of hospital and emergency department costs in the year prior to joining.

The gains to the public payer in terms of health-care costs avoided need to be considered in terms of the costs of the intervention that generate the benefits. Pure North identified three categories of service that it sees as the core of the program — that is, services provided to all participants. The costs associated with the delivery of the program for the fiscal years 2012/13 to 2014/15 are presented in Table 6 and discussed on pages 18 and 19 of the full 2015 published report.

For the ICP seniors, the health-care spending avoided on hospitals and emergency departments are attributable to the program’s fiscal 2013/14 year during which the program cost per participant was \$1,535. The health-care spending avoided using the ICP seniors program effects are 27 per cent of this cost. The health-care costs avoided for hospitals and emergency department visits for the seniors persisting in the Pure North program attributable to the program in the fiscal years 2012/13 and 2013/14 are 43 per cent of the 2013/14 fiscal-year program costs.

As discussed in the 2015 published report, these costs are not necessarily the minimum costs that could have achieved the outcome. If the benefits in terms of health-care costs avoided can be achieved with the projected program cost of \$500 per participant, then each dollar of program cost yields between \$0.81 (ICP seniors) and \$1.33 (persisting seniors) in health-care costs avoided.

These direct reductions in public health-care spending on program participants are not the full benefit of the preventative-care program for the public payer of health-care services in Alberta. To the extent that the program improves health and prevents cases of chronic diseases such as diabetes, cardiovascular disease, cancer and mental illness, there are further future expected reductions in health-care spending that are attributable to the intervention today.

Second, by reducing visits and nights in hospital, and visits to the emergency department, resources are freed up in the medical-treatment system so that there is less need to add bed capacity. We can project the immediate health-care system-level impacts of preventative services if the program effects for seniors persisting in the program can be achieved in the Alberta senior population (age 55 and

over). In 2014, the Alberta population 55 and over is 951,000. Applying the difference-in-difference estimates from the ICP seniors sample in Table 5 to the total Alberta population aged 55 and over, if we use 10.6 nights per hospital stay, which is the mean for our control sample, then there would be 196,000 fewer nights in hospital for the population in the province in 2013/14. These nights in hospital avoided represent 7.4 per cent of the 2,640,201 total hospital days in Alberta in 2012/13. On an annualized basis (total nights avoided divided by 365 days), the hospital nights avoided represent the equivalent of 535 more beds available per year in the province, which is around 6.5 per cent of Alberta's 2013 capacity of 8,230 acute-care beds. In terms of bed capacity, the beds freed up through improved health in the population are equivalent to adding the acute-care bed capacity of Calgary's Foothills Medical Centre.

Applying the persisting difference-in-difference estimates from the senior sample in Table 3 to the total Alberta population aged 55 and over, if we use 10.6 nights per hospital stay, which is the mean for our control sample, then there would be 376,000 fewer nights in hospital for the population in the province in 2013/14. These nights in hospital avoided represent 14 per cent of the 2,640,201 total hospital days in Alberta in 2012/13. On an annualized basis (total nights avoided divided by 365 days), the hospital nights avoided represent the equivalent of 1,030 more beds available per year in the province, which is around 13 per cent of Alberta's 2013 capacity of 8,230 acute-care beds. In terms of bed capacity, the beds freed up through improved health in the population are equivalent to adding the acute-care bed capacity of 1.5 Foothills Medical Centres.

The potential for preventative care to reduce pressure on the province's overburdened emergency departments is also striking. Applying either the ICP seniors ITT or the persisting seniors sample estimates for emergency department visits to the Alberta population aged 55 and over, we project that 120,000 emergency department visits could have been avoided in fiscal year 2013/14. This would represent a six per cent reduction in the 2,116,474 emergency department visits in Alberta in fiscal year 2012/13.